

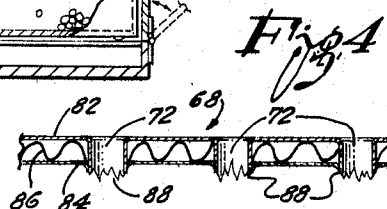
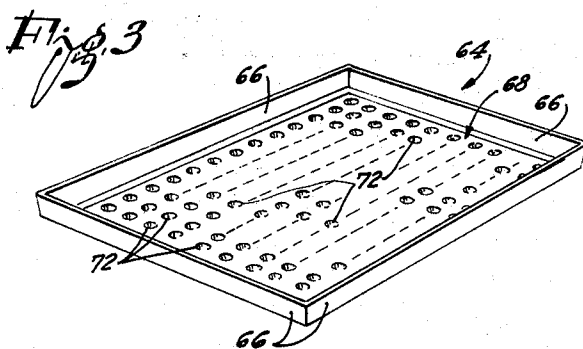
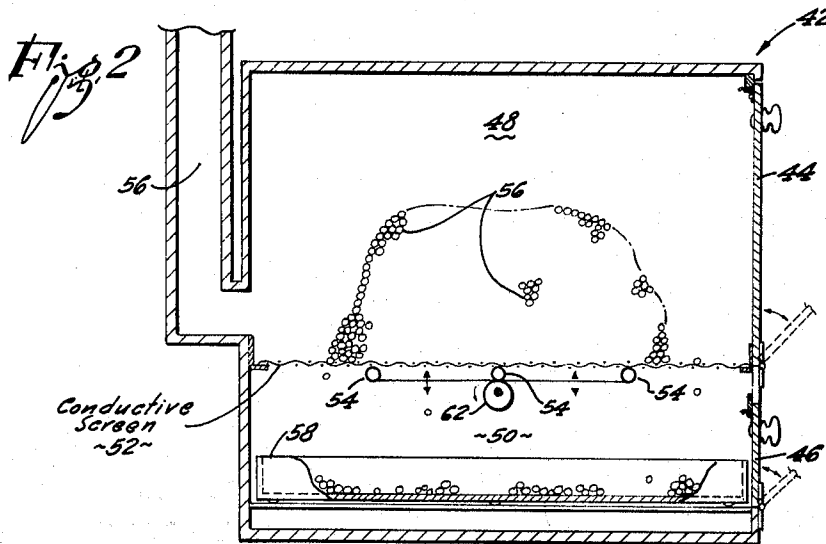
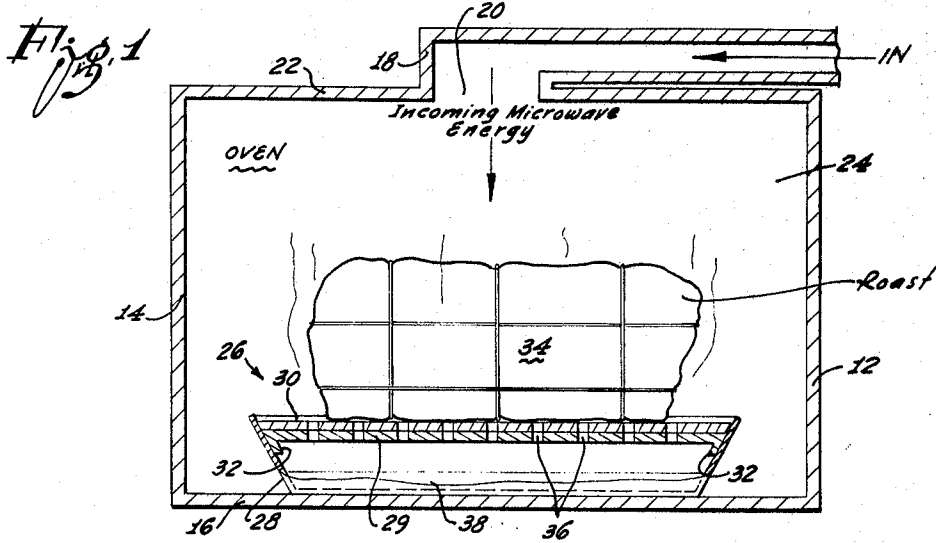
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E. Z. KRAJEWSKI

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MICROWAVE COOKING

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INVENTOR
Edward Zigmund Krajewski

By *Alan C. Rose*
Attorney

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MICROWAVE COOKING

Edward Zigmund Krajewski, Belmont, Calif., assignor to
Litton Precision Products, Inc., a corporation of
Delaware

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This invention relates to microwave cooking, and more particularly to a method and apparatus for increasing the efficiency of microwave cooking.

In the field of microwave cooking, a considerable problem relates to the loss of efficiency resulting from water, meat juices or other liquids which are released from food heated in a microwave oven. These juices tend to absorb microwave energy until they are evaporated, and this evaporation requires the absorption of large amounts of energy. More specifically, the heat of vaporization of water is about 539 calories per gram of water. This means that the evaporation of one unit weight of liquid requires the same amount of energy as would be required to raise the temperature of ten times as much liquid, for example, by more than 50 degrees centigrade.

Accordingly, a principal object of the present invention is to avoid the loss of efficiency which occurs when juices and other liquids are released in the course of microwave heating, without adversely affecting the cooking process in any other way.

A closely related problem in the microwave cooking field is the defrosting of frozen foods such as strawberries, eggs, peas and the like. As a portion of the frozen foods are defrosted and separated from the main mass of the frozen foods, it would be desirable to remove the defrosted portion from the microwave field. This would have the desirable effect of avoiding overcooking the part of the food which is first defrosted.

Accordingly, another object of the present invention is to permit the removal from the heating zone of a microwave oven, of food which had been defrosted and separate it from a mass of frozen food.

In accordance with the present invention, the objects noted above may be achieved through the use of a perforated conducting surface which forms a boundary for the microwave energy of the oven. In the case of the liquids mentioned above, they may readily pass through the perforated sheet or screen and drop into a container below. Similarly, in the case of a mass of food which separates as it is defrosted and cooked to the desired extent, the defrosted portions may drop through the perforations into a container which is located below and out of the microwave field.

An insulating sheet may be provided with apertures which match those of the conducting sheet. Such an insulating member prevents heat loss to the metal pan by conduction and permits uniform heating throughout the remainder of the material in the microwave oven through proper spacing from the conductive sheet, where the energy level is low. In the case of defrosting large masses of material which drop through the screen as they are defrosted, apparatus may be provided for vibrating the perforated sheet or screen so that the defrosted material will more readily drop through the screen. By regulation of the microwave energy level and by delaying drop out from the microwave heating zone, any desired degree of cooking may be achieved.

The novel features which are believed to be characteristic of the invention, both as to its organization and method of construction and operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawing in which illus-

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trative embodiments of the invention are disclosed, by way of example. It is to be expressly understood, however, that the drawing is for the purpose of illustration and description only and does not define limitations of the invention.

In the drawing:

FIG. 1 shows a conventional microwave oven utilizing a cooking pan in accordance with the present invention;

FIG. 2 shows a microwave oven in accordance with the present invention in which a perforated conducting sheet or screen is employed;

FIG. 3 shows an insulating cooking sheet having perforations which match the perforations in the screen of FIG. 2; and

FIG. 4 is a cross-sectional view through the bottom of the sheet of FIG. 3.

Referring to the drawing, FIG. 1 shows a microwave oven having sidewalls 12 and 14 and a bottom 16. Microwave energy is supplied from a source (not shown) through the waveguide 18 to an aperture 20 in the top wall 22 of the microwave oven. Suitable mode mixing and other known adjuncts employed in microwave heating systems may be used. The rear wall 24 may, for example, be a door through which material may be placed into the oven. The source of microwave energy may be a magnetron power supply of a type well-known in the industry.

The present invention relates, in one aspect, to the food supporting pan 26. This pan includes a conductive receptacle portion 28 and a cover which is made up of a highly conductive sheet portion 29 and an insulating sheet portion 30. The conductive sheet may be of aluminum, for example, or other good conducting material. The conductive portion 29 preferably has depending edges 32 to make good electrical contact with the receptacle 28. These edges 32 may make a spring fit with the walls of the receptacle 28 so that the lid is in intimate engagement with the receptacle, and does not merely loosely rest on it in the manner of conventional cooking utensils. In practice, a roast 34 is placed on the insulating sheet 30 for cooking in the microwave oven. As the roast 34 is defrosted and starts to cook, moisture and meat juices drop through the aligned openings 36 in the insulating sheet 30 and the conductive sheet 29. This liquid 38 is collected in the bottom of pan 28.

After it has fallen through the openings 36, the liquid 38 is out of the microwave field and therefore does not absorb energy. In order to avoid the penetration of the microwave energy into the receptacle 28, both the receptacle 28 and the conductive plate 29 should be highly conductive and they should be in intimate engagement along their edges. The depending edges 32 insure the necessary good electrical contact, as noted above. To avoid penetration of the microwave energy through the openings 36, they must be relatively small, in comparison with the wavelength of the microwave energy transmitted through the waveguide 18. In one representative example, the microwave frequency was approximately 2450 megacycles, and the resulting wavelength was approximately $2\frac{1}{2}$ ". Under these conditions, the openings 36 should be less than one quarter wavelength, and preferably $\frac{3}{8}$ " or smaller. In cases where a conducting screen is employed or where the openings are spaced closer together than shown in FIG. 1, the openings should have a smaller cross-sectional dimension, such as $\frac{1}{4}$ " or less, when a frequency of 2450 megacycles is employed. In general, it is desirable that the openings do not have any dimension which is greater than $\frac{1}{4}$ of a wavelength, and the greatest dimension should preferably be less than $\frac{1}{5}$ or $\frac{1}{8}$ of a wavelength. When the foregoing conditions are satisfied, little or no microwave energy will penetrate the container, and no energy will be lost in the evaporation of fluid 38.

FIG. 2 represents an alternative embodiment of the invention in which the oven 42 is provided with two doors 44 and 46. These doors provide access to the chambers 48 and 50 within the oven structure. The two chambers 48 and 50 are separated by a conductive screen 52. This screen is secured to the oven 42 at its edges and is also supported by rods 54 which extend across the width of the oven. The openings in the screen are sufficiently small so that microwave energy supplied through waveguide 56 will not pass through the screen 52. On the other hand, the mesh of the conductive screen 52 is sufficiently big to permit selected materials, which are defrosted and cooked to the desired extent, to fall through the holes into the compartment 50 of the oven.

In operation, a large mass 56 of material to be defrosted is placed on the conductive screen 52. As portions of this mass are defrosted they drop through the screen 52 and into the pan 58. By way of example, the frozen mass 56 may be peas, whole frozen strawberries, shrimp, eggs, or other frozen materials, and as these materials are defrosted, they will drop through the screen 52 into pan 58. The defrosted materials may be retained in the microwave field through the use of an insulating screen and insulating tilted baffle plates which are vibrated, to retain the defrosted material within the microwave field for the desired cooking time period. When all of the material has dropped through the screen 52, the pan 58 may be removed through door 56.

To facilitate the separation action, the supporting rods 54 are interconnected by end rods 60 and these rods are agitated by a mechanical apparatus such as the eccentric wheel 62. The eccentric wheel 62 may be selectively driven by a motor (not shown).

The insulating tray 64 of FIG. 3 may also be employed in connection with the oven 42 of FIG. 2. The insulating tray 64 includes sidewalls 66 and a bottom 68 which is provided with an array of holes 72. The holes 72 in the bottom of the plastic tray 64 have the same spacing as the openings through the conductive screen 52 of FIG. 2. Furthermore, the openings 72 may be formed by a piercing operation from the upper surface so that the edges of the holes 72 extend downwardly. Through the use of this structure, therefore, juices or other liquids which drip through the holes 72, will not touch the wires forming the screen 52. When the insulating tray 64 is employed, a roast may be cooked on its surface with the advantages disclosed above in connection with FIG. 1.

The insulating sheets preferably maintain the food to be cooked spaced from the conductive boundary of the microwave cooking zone, where the energy level is relatively low. It should therefore be at least $\frac{1}{16}$ inch thick and preferably about $\frac{1}{8}$ inch thick. FIG. 4 represents a cross-sectional view through the bottom 68 of the insulating cooking sheet of FIG. 3. It may be formed like a cardboard box, with upper and lower sheets 82 and a

curved box, with upper and lower sheets 82 and a curved spacing sheet 86. Holes 72 pass through all three layers and have downwardly extending portions 88, as mentioned above.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention. Thus, by way of example and not of limitation, the perforated insulating sheets of FIGS. 1 and 3 may be formed of disposable plastic material which may be thrown out after each use. In addition, other mechanical arrangements may be provided which perform the electrical and mechanical functions described above. Accordingly, it is to be understood that the present invention is limited only by the spirit and scope of the appended claims.

What is claimed is:

1. A cooking utensil for use in a microwave oven, comprising, in combination, a closed conductive pan, an apertured electrically conductive cover in intimate conductive engagement with said pan, and an electrically insulating sheet having apertures aligned with the apertures in said the apertures in said conductive cover and insulating sheet being adapted to support an object to be heated in a microwave oven.

2. A cooking utensil adapted for use in a microwave oven, comprising a pan of high conductivity, an apertured electrically conductive cover intimately engaging said pan around its edges, and an electrically insulating sheet mounted above said conductive cover and having apertures aligned with the apertures in said conductive cover, the apertures in said conductive cover and insulating sheet having their largest dimension less than $\frac{1}{4}$ wavelength of the frequency at which said utensil is to be used.

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RICHARD M. WOOD, *Primary Examiner*.

HYMAN LORD, *Examiner*.